

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
1 August 2002 (01.08.2002)

PCT

(10) International Publication Number
WO 02/058463 A2

(51) International Patent Classification⁷: A01N

(21) International Application Number: PCT/US01/45457

(22) International Filing Date: 24 October 2001 (24.10.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/242,423 24 October 2000 (24.10.2000) US

(71) Applicant (for all designated States except US): THE UNITED STATES OF AMERICA, as represented by the SECRETARY OF AGRICULTURE [US/US]; 1400 Independence Avenue SW, Washington, DC 20250-0302 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): SCHRODER, Robert, F., W. [US/US]; 77 W. Green Street, Westminster, MD 21157 (US).

(74) Agents: PENDORF, Stephan, A. et al.; Pendorf & Cutliff, P.O. Box 20445, Tampa, FL 33622-0445 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

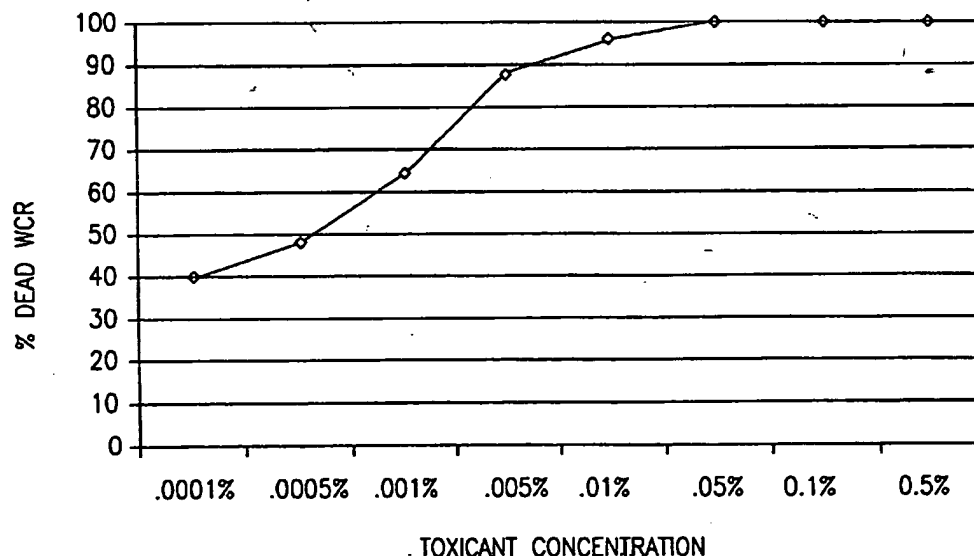
— of inventorship (Rule 4.17(iv)) for US only

Published:

— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: CUCURBITACIN-CONTAINING INSECTICIDAL COMPOSITIONS



(57) Abstract: Diabroticite insects, in particular the corn rootworm, are major pests of corn as well as a variety of other agricultural crops. The invention describes insecticidal aqueous-based compositions which are effective for the control of such insects. The composition comprises cucurbitacin feeding stimulants in combination with toxicants which are insoluble in water or have low to moderate solubility. Additives such as emulsifiers, thickeners and adherents may also be included in the composition.

WO 02/058463 A2



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

CUCURBITACIN-CONTAINING INSECTICIDAL COMPOSITIONS**BACKGROUND OF THE INVENTION****Field of the Invention**

Crop losses due to insect pests have a significant economic impact on the agricultural economy. The corn rootworm (CRW) and other Diabroticite insects, for example, are a major threat to the production of corn in North America. Costs associated with attempts to control CRW combined with monetary losses due to crop damage can exceed \$1 billion per year. Moreover, the CRW causes an additional \$100 million in damage and control costs on cucurbits, peanuts and soybeans. Adult insects have also caused considerable damage to many fruits and have been implicated as carriers of some plant diseases as well.

Chemical pesticides for the control of the CRW pest complex are applied to 12-16 million hectares per year. These chemicals have often been applied as a preventive measure, sometimes unnecessarily, thereby increasing the health risks imposed on the general population as well as on livestock and other farm and domestic animals and wildlife.

The need for an effective agent for the control of pests such as CRW which is also environmentally safe is thus well-established. This invention relates to novel insecticidal compositions effective for the control of insects, Diabroticite insects in particular, and to methods of controlling the insects utilizing the novel compositions.

Description of the Relevant Art

The corn rootworm pest complex (subfamily Galerucinae) is comprised of two taxonomic groups, Virgifera and Fucata. The Virgifera group beetles overwinter as eggs in the soil and are univoltine. This group is comprised of northern corn rootworm (NCR), *Diabrotica longicornis barberi* Smith & Lawrence, from the upper Mississippi Valley; western corn rootworm (WCR), *D. virgifera virgifera* LeConte, from the midwestern U.S.; and Mexican corn rootworm (MCR), *D.v. zea* Krysan & Smith, from the south central U.S.

The Fucata group beetles overwinter as adults and are multivoltine. They include the western spotted cucumber beetle (WSCB), *D. undecimpunctata undecimpunctata* Mannerheim, ranging from the far western U.S. into the upper Baja Peninsula; the banded cucumber beetle (BCB), *D. balteata* LeConte, from the southeast U.S.; and the southern corn rootworm (SCR), *D.u. howardi* Barber, commonly known as the spotted cucumber beetle in the adult stage and ranging east of the Rockies from southern Canada into Mexico. In addition to these Diabroticine beetles, there are *Acalymma vittatum* (Fabricius), the striped cucumber beetle ranging from Mexico to Canada, primarily east of the Rockies and *A. trivittatum* (Mannerheim), the western striped cucumber beetle, found in the west.

Both larvae and adults are responsible for extensive feeding damage. For example, larvae of SCR hatch from eggs of overwintering adults and either feed on seedling corn roots or

bore into the base of the stem. They also attack peanut crops by penetrating the developing peanut and either consuming it or facilitating attack by disease-causing microorganisms.

After feeding, diabroticine larvae pupate and emerge from the ground as adult beetles. Multivoltine species (e.g. SCR) can produce up to three generations a year. The univoltine beetle (e.g. NCR or WCR) life cycle begins with eggs laid below the surface of the soil in the fall. In early spring, the larvae hatch and begin to feed. Beetles emerge from mid-July through August, with male beetles emerging about 1 week before the females.

An interesting relationship between insect herbivores and their host plants is the phenomenon exhibited by insects feeding compulsively on phytochemicals that may be toxic to other insects. This phenomenon occurs between CRW and their ancestral plant hosts, the Cucurbitaceae. These plants produce very bitter compounds, cucurbitacins, which are phagostimulants for many of the CRW pest species (Metcalf, R.L. 1986. *J. Chem. Ecol.* vol. 12, pp. 1109-1124; Metcalf and Lampman. 1989. *J. Econ. Entomol.* vol. 82, pp. 1620-1625; Tallamy and Kriachik. 1989. *Amer. Nat.* vol. 133, pp. 766-786; Metcalf and Rhodes. 1990. In: *Biology and utilization of the cucurbitaceae*. Bates et al., eds. Comstock, Ithaca, NY; DeMilo et al. 1998. *J. Entomol. Sci.* vol. 33, pp. 343-354; Schroder et al. 1998. *J. Entomol. Sci.* vol. 33, pp. 355-364).

There has been a major effort to replace ineffective and environmentally undesirable soil insecticides using baits which include a combination of cucurbitacins and toxicants (Metcalf et

al. 1987. *J. Econ. Entomol.* vol. 80, pp. 870-875; Lance, D.R. 1988. *J. Econ. Entomol.* vol. 81, pp. 1359-1362; Weissling et al. 1989. *Entomol. Exp. Appl.* vol. 53, pp. 219-228; Lance and Sutter. 1990. *J. Econ. Entomol.* vol. 83, pp. 1085-1090; Lance and Sutter. 1991. *J. Econ. Entomol.* vol. 84, pp. 1861-1868; Weissling and Meinke. 1991. *Environ. Entomol.* vol. 20, pp. 945-952; Brust and Foster. 1995. *J. Econ. Entomol.* vol. 88, pp. 112-116; Schroder et al., *supra*). Lacing baits with cucurbitacins causes insects to compulsively feed on them and subsequently die from the insecticides which are also present in the bait compositions. The increased feeding brought on by the cucurbitacins results in a reduction in the amount of insecticide necessary for an effective formulation by up to about 90-95%. The baits are pest specific and capable of killing 99% of the insects consuming them (Tallamy and Halaweish. 1993. *Environ. Entomol.* vol. 22, pp. 925-932). For example, the semiochemical-based insecticide carbaryl, in a formulation bait specific to CRW (Chandler et al. 1995. In: *Clean water, clean environment, 21st century team agriculture, working to protect water resources*. Conf. Proceed. vol. 1, pp. 29-32), has been under commercial development and evaluation in the U.S. Department of Agriculture, Agricultural Research Service, Corn Rootworm Management Areawide Program on limited corn acreage in the Corn Belt.

The goal of entomologists in refining IPM practices is to rely less on synthetic chemicals in baits and, if possible, to find other approaches to managing the CRW (Butler, R.E. 1992. Seed

World. vol. 130, pp. 8-10). Various attempts have therefore been made to develop effective formulations which achieve this goal. Baits such as those reported by Metcalf et al., *supra*, were prepared from *Cucurbita* fruits which were dried, ground and impregnated with insecticides and volatile attractants. These baits were then scattered over plots of sweet corn, with some of the bait on the leaves and silks of the ears of corn. Lance and Sutter (1992. *J. Econ. Entomol.* vol. 85, pp. 967-973) also described a bait formulation containing an insecticide, a feeding stimulant and volatile attractants. In both instances, volatile attractants were included since cucurbitacins, although recognized as powerful feeding stimulants, have not been considered effective as attractants. Delivery of the insecticide was therefore accomplished by first attracting the insect, then stimulating it to feed on the insecticide-laced bait.

Other compositions and methods have also been utilized in attempts to control the CRW. Guss et al. (U.S. Pat. No. 4,565,695, 1986) suggest the use of synthetic pheromone for mating disruption or for use in combination with larval insecticides. Doane et al. (U.S. Pat. No. 5,464,618, 1995) describe a gustatory stimulant comprising dried and powdered plant material containing cucurbitacins, a lubricant and an adherent to be used in combination with an insecticide for adult beetles. Munson et al. (U.S. Pat. No. 5,571,522, 1996) describe a feeding stimulant to be used in combination with an insecticide where the feeding stimulant is corn germ. Lew et al. (U.S. Pat. No. 5,690,951, 1997) describe a bait composition where insecticide and feeding

stimulant are mixed with a molten polymeric binding agent, formed into droplets, then cooled and treated to form dry particles. A major drawback to these approaches, however, is a lack of consistency in the delivery of the insecticide to the targeted insect. While cucurbitacins are potent feeding stimulants, they do not appear to serve as attractants, so the targeted pests must be in the immediate vicinity of the baits in order for them to be effective. A substantial portion of the insecticide in the dry formulations may thus be wasted because it is never consumed. This waste is deleterious not only because of cost and ineffectiveness, but also because it results in insecticide remaining in the fields to contaminate the soil, ground water and other sources of water such as lakes, rivers and streams.

Schroder et al. (U.S. Pat. Nos. 5,968,541, 1999 and 6,090,398, 2000) describe aqueous bait compositions which are effective as insecticides for the control of Diabrotica insects and contain cucurbitacin feeding stimulants and soluble toxicants, such as photoactive xanthene dyes. Although these compositions solved the delivery problems associated with dry particulate formulations, they are limited to those toxicants which are water soluble, and do not include those toxicants which are insoluble or have moderate to low solubility.

The search has therefore continued for formulations that are aqueous-based and effectively utilize water-insoluble toxicants and those having low to moderate solubility.

SUMMARY OF THE INVENTION

I have now discovered an aqueous composition which is consistently effective for the control of insects, Diabroticite insects in particular, and comprises a cucurbitacin feeding stimulant and a toxicant, where the toxicant is either insoluble in water or has low to moderate solubility. In accordance with this discovery, it is an object of the invention to provide the composition for the control of insects, such as Diabroticite insects.

It is also an object of the invention to provide a method of controlling Diabroticite insects by applying the composition in amounts effective for reducing the insect population.

Other objects and advantages of the invention will become readily apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows the LC90 of a synthetic pyrethroid esfenvalerate (Asana® XL 0.66 EC, DuPont Agricultural Products, Wilmington, DE) in combination with bitter Hawkesbury watermelon juice applied as a foliar spray on cucurbits against southern corn rootworm (SCR) adults. Results were achieved at approximately 0.003 % (w/v) in 48 hours.

Fig. 2 shows the effects of varying concentrations of two insecticides: imidacloprid (Admire® 2F, Bayer, Kansas City, MO) and carbaryl (Sevin® 50W, Rhone-Poulenc, Research Triangle Park, NC) in combination with Hawkesbury watermelon juice on southern corn rootworm (SCR) mortality.

Fig. 3 shows the effects of insecticides in combination with bitter Hawkesbury watermelon juice applied by ground sprayer on corn in comparison to the commercial product Slam® [(13%), Micro Flo Co., Memphis, TN], 8.0 fl oz: red dye, 1 oz; red dye, 3 oz; bifenthrin [Capture® (2EC), FMC Corp., Philadelphia, PA], 3.2 fl oz; methyl parathion [Penncap-M® (2FL), Elf Atochem North America, Philadelphia, PA], 2.4 fl oz; fipronil [(0.44SC), Rhone-Poulenc, *supra*], 0.16 oz. Mortality of CRW adults after 24-hr exposure is indicated.

Fig. 4. shows the effects of insecticides in combination with bitter Hawkesbury watermelon juice applied by aerial treatment on corn in comparison to the commercial product Slam® [(13%), Micro Flo Co., *supra*], 8.0 fl oz: fipronil [(0.44SC), Rhone-Poulenc, *supra*], 0.16 oz; methyl parathion [Penncap-M® (2FL), Elf Atochem North America, *supra*], 2.4 fl oz. Mortality of CRW adults after 24-hr exposure is indicated.

Fig. 5 shows the mortality of Japanese beetles treated with carbaryl (Sevin® XLR Plus, Rhone-Poulenc, *supra*) at 3.2 oz/acre in bitter Hawkesbury watermelon juice by aerial application.

DETAILED DESCRIPTION OF THE INVENTION

Schroder et al. (1998, 1999, 2000, *supra*) disclosed aqueous compositions containing cucurbitacin feeding stimulants and water soluble toxicants. A number of effective toxicants are water-insoluble or have low to moderate solubility, however; therefore formulations for such toxicants were investigated for use in aqueous compositions which can be applied relatively uniformly on

plants where beetles are more active and feeding is preferred. Useful toxicants for the control of Diabrotica which are insoluble or have limited water solubility are well known in the art and include, but are not limited to, carbamates such as carbaryl and aldicarb, organophosphates, fiproles, pyrethroids, pyrazoles, phenylpyrazoles, imidachloprids, various microbials and microbiol by-products such as toxin-producing bacteria (e.g. *Bacillus thuringiensis*) and entomopathogenic viruses and fungi (e.g. baculoviruses).

Most insecticides are commercially available in particle form, such as dry flowables, dusts or wettable powders, or as emulsifiable concentrates, flowables or invert emulsions.

Cucurbitacins are recommended feeding stimulants and are known and described in the art for that purpose (see Metcalf et al., 1987, *supra*; Rhodes et al. 1980. *J. Am. Soc. Hort.* vol. 105, pp. 838-842; Metcalf et al. 1981. *Cucurbit. Genet. Coop. Rep.* vol. 4, pp. 37-38; Metcalf, R.L. 1985. *Bull. Ill. Natl. Hist. Surv.* vol. 33, pp. 175-198; Metcalf and Rhodes, Canadian Patent No. 1,195,922, 1985; How et al. *Environ. Entomol.* vol. 5, pp. 1042-1048; Lew et al., 1997, *supra*; DeMilo et al., 1998, *supra*; Schroder et al., 1998, *supra*, all herein incorporated by reference). Conventionally, the compounds are obtained by extraction from Cucurbitaceae plants. Examples include, but are not limited to, melons such as cantaloupe, watermelon, bitter Hawkesbury watermelon, gourds such as bitter buffalo gourd, cucumbers and squash such as zucchini. The plant material may be dehydrated, then ground into a powdery material. Preferably, the

plant material may be ground up, solid material filtered off and the filtrate (or juice) utilized. This juice contains the feeding stimulants and may be utilized effectively as a crude extract.

In a particularly preferred embodiment, the bitter mutant of Hawkesbury watermelon (BHW), *Citrullus lanatus* (Thunb.) Matsum. & Nakai. (Syn. *Citrullus vulgaris* (Schrad)- is the source of the cucurbitacin feeding stimulants. The melon is ground to pulp and the juice containing the cucurbitacins extracted. The extraction may be carried out under pressure, as in a cider or hydraulic press or a commercial centrifuge, then filtered and utilized directly as a crude liquid extract. It may also be concentrated, then diluted for use as needed. The juice may also be frozen for long-term storage (i.e. months). It may be concentrated by evaporation, spray-drying, freeze-drying or other means to about 5 to about 12% initial volume or weight of the juice (or crude extract).

A number of related cucurbitacin compounds have been isolated and identified and are generally used as mixtures. Investigations have been carried out to determine the most effective, and it was found that cucurbitacin E or cucurbitacin E-glycoside had the most powerful effect (DeMilo et al., 1998, *supra*). In addition, it has lower mammalian toxicity than any of the other cucurbitacin compounds and is water soluble, an important advantage for aqueous formulations. It is also the most abundant cucurbitacin in bitter Hawkesbury watermelon, an added benefit for utilizing BHW juice extract in the formulation of the composition.

The cucurbitacins are also commercially available, although they are at present somewhat expensive.

Additives such as adherents or sticking materials, emulsifiers, thickeners such as starch, stabilizers, oils, preservatives, antifoam agents and/or buffers may also be included in the composition as needed. These materials are well known in the art and are commercially available. In addition, attractants may also be utilized if deemed necessary. While it has not yet been established experimentally, observations suggest that the cucurbitacins themselves may have some attractant capability.

The insecticidal composition is prepared by providing feeding stimulant at an effective concentration. This may be accomplished by mixing feeding stimulant concentrate with water to the desired concentration. An effective feeding stimulant concentration range is from about 0.0001% to about 10% (w/v). Single strength BHW juice has been utilized effectively experimentally and contains about 0.03 to about 0.07 % (w/v) cucurbitacins. The amount utilized is not critical, as long as there is enough feeding stimulant present in the composition to cause the insects to feed compulsively. An effective amount of toxicant is added with mixing to the feeding stimulant preparation. This amount is significantly less than that recommended for use by manufacturers and generally ranges from about 0.1% to about 20% of the recommended amount, depending on the particular toxicant utilized. In addition, if deemed useful, mixtures of toxicants may also be utilized.

For example, a useful formulation may be prepared by

combining a crude extract of BHW juice at a cucurbitacin concentration of from about 0.0001% to about 10% (w/v) with fipronil (a phenylpyroazole) at a concentration of about 2 g active ingredient (A.I.)/acre. [NOTE: Since the recommended amount is about 59 g A.I./acre, the composition contains about 3.3% of the recommended amount.] Taking the application method into consideration, a feeding stimulant concentration of about 0.0003% to about 0.002% (w/v) in a volume of about 5 to about 10 gal/acre applied by conventional ground spray equipment, such as tractor-mounted boom sprayers, backpack sprayers, etc., would be effective, while a concentration of about 0.002% to about 0.09% (w/v) in a volume of about 0.5 to about 2 gal/acre would be effective for aerial application. A water-soluble starch or other thickening agent such as Mira Spense® 626 (A.E. Staley Mfg. Co., Decatur, IL) may be added at a concentration of from about 0.1% to about 5% (w/v), and/or a sticker such as Gelva® (Monsanto Corp., St. Louis, MO) or Lastic® (Helena Chemical Co. St. Louis, MO) may be added at a concentration of from about 0.1% to about 3% (w/v).

Studies were carried out to investigate the effectiveness of various commercially available insecticides in combination with feeding stimulant.

The effectiveness of the synthetic pyrethroid esfenvalerate (Asana® XL 0.66 EC, DuPont Agricultural Products, *supra*) in combination with bitter Hawkesbury watermelon (BHW) juice containing cucurbitacins at approximately 0.003% (w/v) was measured by determining the LC90 of the composition. The

experiment was carried out over a 48-hr period with toxicant concentrations ranging from 0.0001% - 0.5% (w/v). The composition was applied as a foliar spray on cucurbits against southern corn rootworm adults. Results showed a 95% reduction of the recommended rate of Asana® XL (5.8 - 9.6 fl oz/acre) to be effective (see Fig. 1).

Varying concentrations of the two insecticides imidacloprid (Admire®, Bayer, *supra*) and carbaryl (Sevin® 50W, Rhone-Poulenc, *supra*) were also tested with BHW juice. Effects on mortality are shown in Fig. 2.

The composition is applied to target plants (corn, cucurbits, peanuts and other agricultural crops attacked by the CRW) by conventional ground and aerial spraying equipment. It is applied to cucurbits, for example, at the first sign of CRW adults, usually at the early seedling stage. Treatments are applied weekly for about 3 weeks or until adult CRW populations decline below economic injury levels. In corn, treatment may begin at first evidence of adults present on corn, at the time gravid females reach about 20% of the population or at the time of silking. Treatments may be repeated until the population of adults declines below economic injury levels. Trap collections and/or counts of living and dead beetles in the treated corn may be utilized to estimate population levels.

Field trials of various commercially available toxicant/BHW juice feeding stimulant compositions were also carried out and described in the following examples. In conjunction with studies being conducted on CRW, the effects of the insecticidal

composition on Japanese beetle were also investigated with positive results. The examples are intended only to further illustrate the invention and are not intended to limit the scope of the invention as defined by the claims.

All references cited herein are herein incorporated by reference.

EXAMPLES

Example 1. Field Trials on Corn with Carbaryl/BHW Juice.

A composition of BHW juice containing carbaryl (Sevin® XLR, Rhone-Poulenc, *supra*) at 4 fl oz active ingredient (A.I.)/acre was applied by ground sprayer on corn. This treatment was compared to a control and to the commercial product Slam® (Micro Flo Co., *supra*), a dry cucurbitacin formulation mixed with carbaryl, at the recommended rate of 4 fl oz A.I./acre. Applications were made at a rate of 5 gal/acre using a Modern Flow high clearance sprayer at a speed of about 2 mph, using TX-3 hollow cone nozzles. Treatments were replicated 5 times on plots 12 rows wide by 100 ft long. Prior to the treatments, 73 cm x 95 cm wood frame dead beetle trays were placed in each plot and dead beetle counts made periodically thereafter. At 24 hr, mortality counts of adult corn rootworms showed 45 dead in the carbaryl/BHW juice trays and 30 dead in the Slam® trays, an increase in mortality of 33% in the carbaryl/BHW juice plots over the Slam® plots.

Example 2. Field Trials on Corn with Spinosad/BHW Juice.

Studies were carried out as in Example 1, with Spinosad (Dow AgroSciences LLC, Indianapolis, IN) as the toxicant at the treatment rate of 0.9 oz/acre. Carbaryl, the active ingredient in Slam®, was doubled to 8 fl oz/acre. Mortality counts made in 24 hours were 165 in Spinosad plots and 105 in Slam® plots, 37% higher for Spinosad over Slam®. Mortality counts also revealed a consistently higher mortality rate in the Spinosad plots over the Slam® plots during a 9-day post-treatment sampling period.

Example 3. Ground Application on Corn with Selected Commercial Toxicants/BHW Juice.

Five toxicants were each formulated with BHW juice, a sticker and a thickener and applied to corn at 5 gal/acre using a high clearance sprayer. The treatments evaluated on a per acre basis were 1) red dye at 1 oz; 2) red dye at 3 oz; 3) bifenthrin (Capture® 2EC, FMC Corp., *supra*) at 3.2 fl oz (10% of recommended rate); 4) methyl parathion (Penncap-M®, Elf Atochem North America, *supra*) at 2.4 fl oz (10% of recommended rate); 5) fipronil [(.44SC), Rhone-Poulenc, *supra*] at 0.16 oz (7% of recommended rate) and 6) Slam® (13%) at 8 fl oz. Treatments were replicated 4 times on plots 12 rows wide by 150 ft long. Prior to treatments, 73 cm by 95 cm wood frame dead beetle trays were placed in each replication, and dead beetle counts were made 24 hours after treatment. Results are shown in Fig. 3. At 24 hours, there was an increase in mortality of all the toxicants tested over Slam®, the standard commercial bait currently utilized for control of adult corn rootworms. For example, fipronil applied

at 4 g or 0.16 oz/acre (7% the recommended rate) killed 44% more beetles than Slam®. Pennncap®-M at 2.4 fl oz/acre (10% the recommended rate) also killed more beetles than Slam®.

Example 4. Aerial Application on Corn of Fipronil (.44SC) and Pennncap-M® (2FL)/BHW Juice.

Aerial treatments were applied to corn plots. The size of the plots were 50 ft wide by 1320 ft long (1.5 acres). Fipronil at a rate of 4 g (0.16 oz)/acre was mixed with BHW juice and applied at a rate of 1 gal/acre. The second treatment, Pennncap-M®, was added to BHW juice formulation at 2.4 fl oz/acre, a rate of 10% the recommended rate for treatment for adults. Slam® was applied at a rate of 8 oz/acre. The applications were made with a Piper Pawnee PA-25 aircraft equipped with TeeJet D6 nozzles, calibrated to spray 1 gallon of the formulation per acre. Prior to treatment, 6 dead beetle trays spaced 30 meters apart were placed in the center of each treatment. Dead beetle counts were made 24 hr after treatment. Results are shown in Fig. 4. The dead beetle count in the fipronil plot were 50% higher than the high rate of the commercial bait Slam®. Similar counts were observed in the Pennncap-M at 44% higher than Slam. The test clearly demonstrated that low rates of fipronil and Pennncap-M formulated with BHW juice performed better than the commercial product Slam®.

Example 5. Field Trials on Soybean with Carbaryl/BHW Juice.

The control of Japanese beetle, *Popillia japonica* Newman (Coleoptera:Scarabaeidae), was tested in an 84-acre field of

soybeans using carbaryl (Sevin® XLR Plus) at 3.2 fl oz/acre (10% of the mean recommended rate for Japanese beetle control) and BHW juice (12 fl oz/acre). Pre-treatment sweep samples throughout the field were obtained. Ten sites were randomly chosen, and a 25-sweep sample was taken at each site. Application of the insecticidal composition was made with a Grumann Aircat biplane outfitted with 13 D8 nozzles. Conditions were sunny, ~77°F, with 2-3 mph winds. Results are shown in Fig. 5. In pre-treatment counts, a total of 387 beetles were collected at the ten sites ($\bar{x} = 38.7 \pm 15.3$). Following treatment, a total of 26 beetles were collected at ten sites ($\bar{x} = 2.6 \pm 2.8$), a 93% reduction in pre-treatment population levels.

I claim:

1. An aqueous insecticidal composition comprising an insecticidally effective amount of a toxicant and a feeding stimulant, wherein said toxicant is insoluble or has moderate to low solubility in water and said feeding stimulant comprises at least one cucurbitacin.
2. The composition of claim 1, wherein said composition is effective against Diabroticite insects.
3. The composition of claim 1, wherein at least one cucurbitacin is cucurbitacin E or cucurbitacin E-glycoside.
4. The composition of claim 1, wherein said toxicant is selected from the group consisting of carbamates, organophosphates, fiproles, pyrethroids, phenylpyrazoles, pyrazoles, imidachloprids, microbials and microbial by-products and entomopathogenic viruses.
5. The composition of claim 1, wherein said composition further comprises at least one additive selected from the group consisting of adherents, thickeners, emulsifiers, oils, stabilizers, stickers, preservatives, antifoam agents and buffers.
6. The composition of claim 1, wherein said composition further comprises a thickener and wherein said thickener is a starch.
7. The composition of claim 6, wherein said composition further comprises an adherent.
8. The composition of claim 1, wherein said cucurbitacin is present at a concentration of from about 0.0001% to about 10%

(w/v).

9. An aqueous insecticidal composition comprising juice extracted from cucurbitacin-containing plant material and an insecticidally effective amount of a toxicant, wherein said toxicant is insoluble or has moderate to low solubility in water.
10. The composition of claim 9, wherein said composition is effective against Diabroticite insects.
11. The composition of claim 9, wherein said cucurbitacin-containing plant material is bitter Hawkesbury watermelon.
12. The composition of claim 9, wherein at least one cucurbitacin is cucurbitacin E or cucurbitacin E-glycoside.
13. The composition of claim 9, wherein said toxicant is selected from the group consisting of carbamates, organophosphates, fiproles, pyrethroids, phenylpyrazoles, pyrazoles, imidachloprids, microbials and microbial by-products and entomopathogenic viruses and fungi.
14. The composition of claim 9, wherein said composition further comprises at least one additive selected from the group consisting of adherents, thickeners, emulsifiers, oils, stabilizers, stickers, preservatives, antifoam agents and buffers.
15. The composition of claim 9, wherein said composition further comprises a thickener and wherein said thickener is a starch.
16. The composition of claim 15, wherein said composition further comprises an adherent.

17. The composition of claim 9, wherein said cucurbitacin is present at a concentration of from about 0.0001% to about 10% (w/v).
18. A method for the control of insects, said method comprising applying an amount of the insecticidal composition of claim 1 or 9 effective for the control of said insects.
19. The method of claim 18, wherein said insects are Diabroticite insects.
20. The method of claim 18 or 19, wherein said insecticidal composition is applied by ground spraying or aerial spraying.

1/5

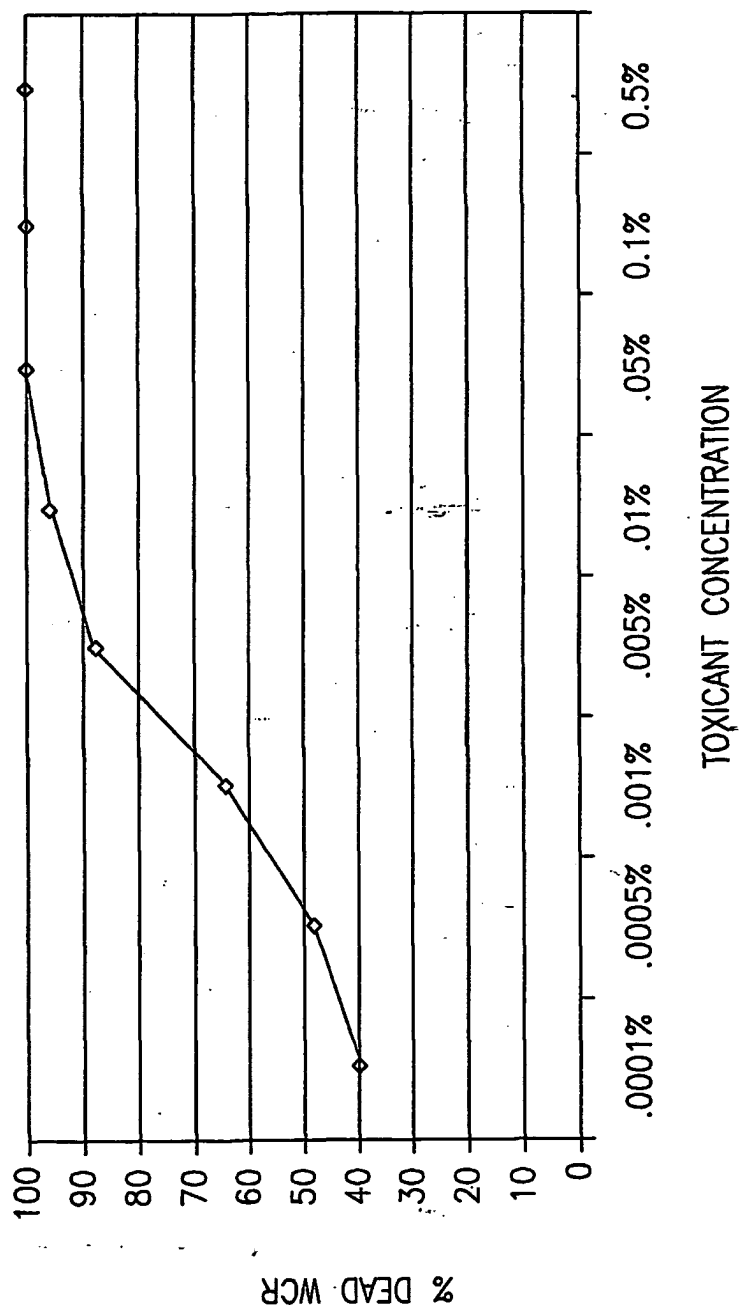
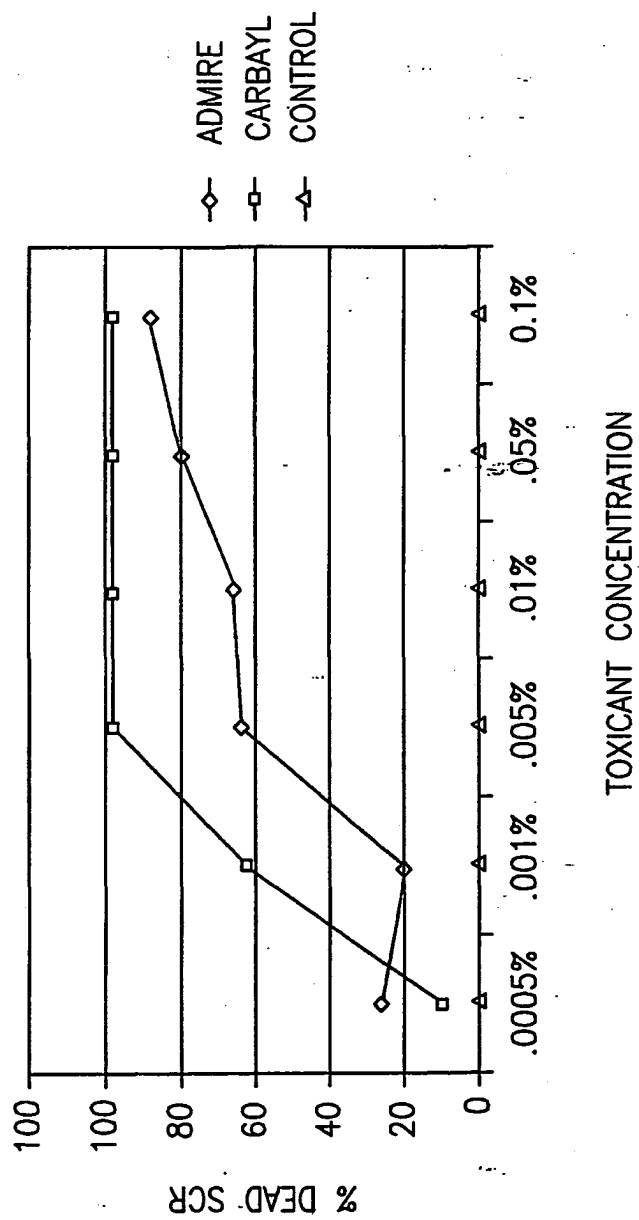


Fig. 1

2/5

Fig. 2

3/5

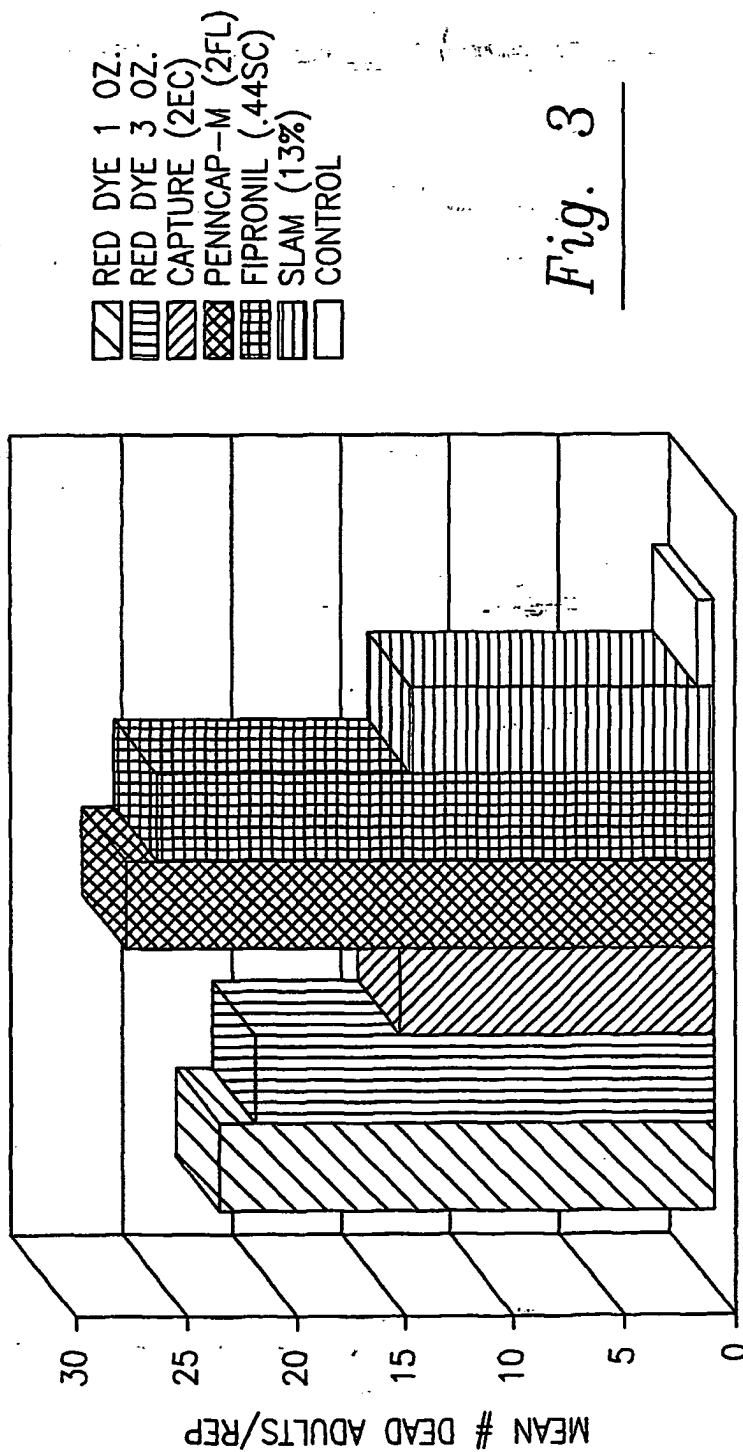
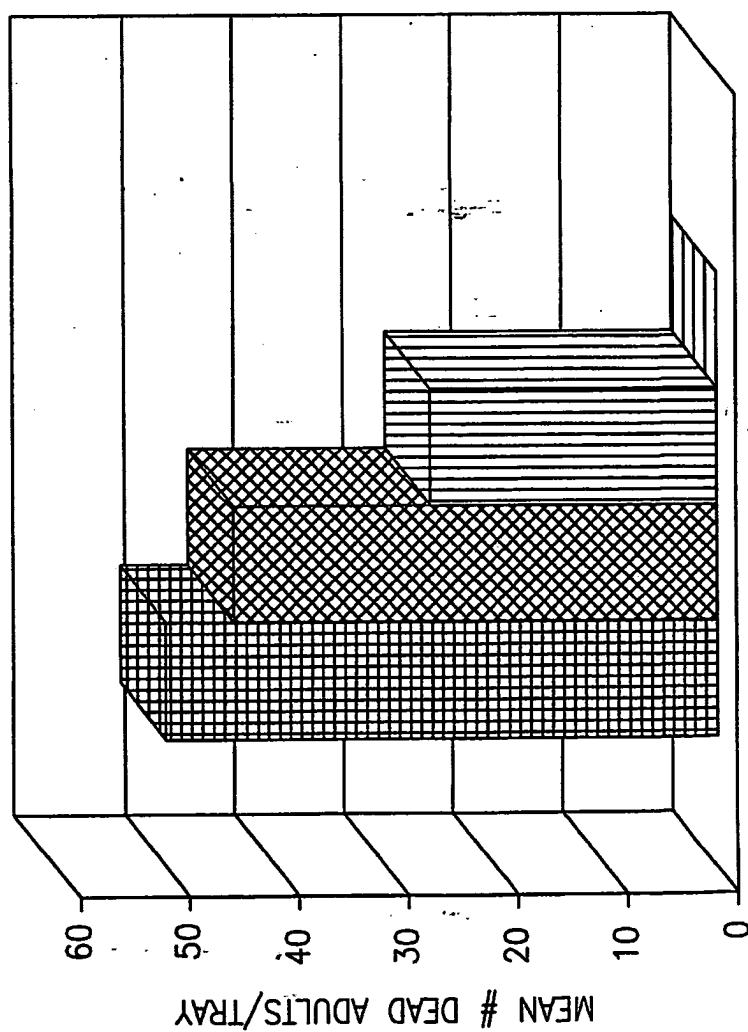


Fig. 3

4/5

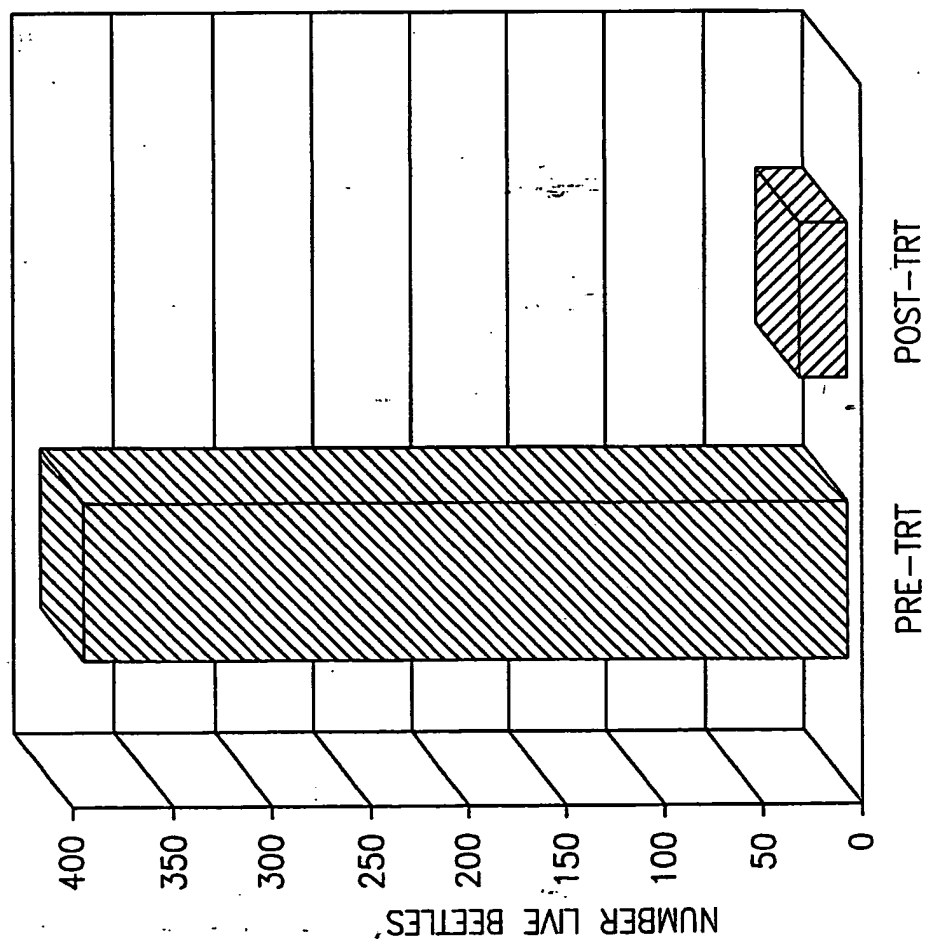
FIPRONIL (.44SC)
 PENNCAP-M (2FL)
 SLAM (13%)
 CONTROL

Fig. 4



5/5

Fig. 5



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.